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Influence of the Ginning Process on the Quality of Raw Cotton

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Abstract

Technological progress consists of the development of improving techniques and technology. It occurs through the creation and implementation of new, more productive, economic and design-perfect machines, mechanisms, apparatus, devices, structures and the development of new technological processes. The direct process of technical progress lies in improving the instrument of labor, which is expressed mainly in increasing the power of the machine, the speed of its operation, improving and simplifying its design, in the transition to more advanced technical connections, as well as automating the control system of the main elements of automatic control systems, is a sensor giving information about the operating mode of technological machines.

Keywords

Cotton, Saw Gin, Feed Rollers, Roll Box, Seed Roll, Productivity, Pressure, Density, Cotton Movement Speed

1. Introduction

The main machine of gin factories is gin, the task of which is to separate the fiber from cotton seeds, provided that its natural properties are preserved.

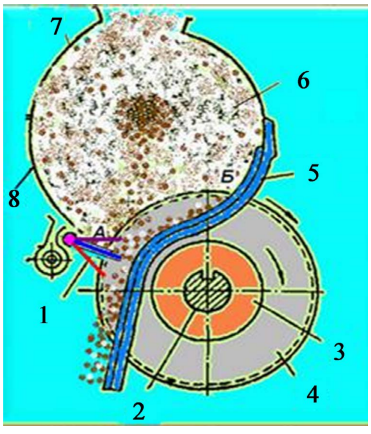
To date, large scientific research has been carried out and is being carried out to improve equipment and technology in this direction. New designs of fiber-cleaners of the DP-130 brand and installations for mechanization and automation of production processes have been created and introduced.

The process of ginning cotton on saw gins is based on the principle of the saw teeth breaking off the fibers from the cotton seeds rotating inside the working chamber. The raw cotton coming from the feeder, falling into the inside of the working chamber onto the rotating saws, is rolled into a roller and carried away by the saw teeth into rotation at a speed five times lower than the saw rotation

speed. The smoothness and correct construction of the internal shape of the working chamber is very important for facilitating the rotation of the raw roller. The uneven shape of the working chamber (Figure 1) and its rough inner surface cause an increase in friction forces, as a result of which the consistency of the saw rotation with the rotation of the raw roller is disrupted, the raw roller clogs and stops. The work is jerky, while productivity decreases and fiber defects increase. The slower the raw roller rotates, the more often its bottom is, the more the fiber production decreases. The raw roller is pressed lightly onto the teeth of the saw cylinder, resting on the curved surface of the working chamber. The teeth of the rotating saws cut into the mass of raw cotton, pick up bundles of fibers between the mouths of the teeth and pull them towards the grates. Further, the mass of the raw roller, rotating, rushes up the front wall of the working chamber, where the saws pull the captured fibers through the slots of the grate, as a result of which the fibers break off at the seed or are pulled out of the seed skin. If there are burrs on the teeth or if the saws are incorrectly installed, the side edges of the teeth act like scissors and there is a risk of cutting the fibers. The more fibers are captured by the saw teeth, the easier and with a higher speed the raw roller rotates and the sooner the advanced seeds come out of the working chamber, the higher the productivity of the gin. But with an increase in the mass of the raw roller, the size of the cross section of the chamber also increases, and with an increase in the section of the working chamber (with a constant diameter of the saw blades), additional friction forces of the raw roller against the walls of the working chamber arise, which can disrupt its movement. The mass of fiber collected in the central part of the raw roller can increase the productivity of the working chamber by reducing the average residence time of seeds in the chamber [1] [2] [3].

2. Materials and Methods

A.D. Grober conducted theoretical and experimental research on the study and



1—comb, 2—shaft, 3—inner diameter of the saw cylinder, 4—saw, 5—grate, 6—raw roller, 7—upper part of the working chamber, 8—lower part of the working chamber.

Figure 1. Technological diagram of the working chamber.

mathematical expression of the characteristics of the gin process. He determined the statistical patterns of the ginning process. In particular, the author showed that reducing the unevenness of the cotton supply to the gin working chamber and stabilizing the cotton process improves the quality of the cotton fiber [4] [5] [6].

Analysis of the development of fundamental research on saw gin allows us to determine the ways of its optimization. It is necessary to stabilize the gin process in order to increase the productivity of the gin and improve the quality of the fiber.

In ginneries, the density of the raw roll is subjectively set and adjusted during ginning. To do this, set the gin feed rate, which is determined by work experience, depending on the cotton navigator, and then proceeds to adjust the density of the raw roller and the dropping of seeds. Experimental data on the influence of the density of the raw roll on the quality of fiber and seeds were obtained by B.I. Bekmirzaev (see **Table 1**). It can be seen that the minimum fiber damage is observed when the density of the raw roll is 325 kg/m^3 for grade I cotton, and 290 kg/m^3 for grade III cotton [7] [8] [9].

The condition for the withdrawal of seeds from the center of the raw roller, their influence on the ginning process and their results were obtained in the process of tests in production. Also, the influence of additional seed withdrawal on the quality of products and the density of the raw gin roll was determined. In this gin design, the seed removal is provided by a separate auger, which in turn can damage the seeds. If we do not take into account individual design improvements, then we can conclude that the basic principles laid down in the designs of many years ago are preserved to this day. The indispensable components of saw gins of all brands are the working chamber, the saw cylinder, the grate

Table 1. Influence of the density of the raw roll on the quality of the fiber in the processing of medium staple cotton of I and III grades.

I-cotton grade		III-cotton grade	
Density of raw cushion, kg/m^3	**Percentage of fiber defects in ginning processes, %**	**Density of raw cushion, kg/m^3**	**Percentage of fiber defects in ginning processes, %**
171.8	2.12	183.6	3.1
196.4	1.67	248.1	2.05
314.9	1.24	255.7	1.97
326.3	1.15	280.5	1.96
328.2	1.33	288.2	1.94
344.5	1.81	293.9	1.86
349.2	2.48	301.5	2.02
364.5	2.73	314.9	2.35
		337.8	2.8
		351.1	3.04

and the removable device [10] [11] [12] [13].

The density of the raw roller is determined by the dynamic balance of the cotton and the masses of fiber and seeds emerging from it, which are fed into the chamber with the help of a feeder. The role of the feeder in the design of the variable speed variator is very important in maintaining this balance. Therefore, most of the research in this area has been devoted to improving the design of the pulse variator, which is still the main means of adjustment. Cotton from the feeder is fed in a continuous flow into the working chamber of the genie [14] [15] [16].

Gnedenko V.I., Kuleshova M.F., Matmusaev Yu.M. In their scientific work, they tried to regulate the amount of cotton transferred using a variator. At the same time, the principle of self-regulation of the average angular velocity of the drive shaft, depending on the moment of resistance, was used to create a new design of a pulsed variator.

In the new variator, the initial tension created by the deformation of the spring ensures that the composite shaft acts as the primary element under a certain load. The hinges of the four-way mechanism oscillate with an amplitude determined by the ratio of the lengths.

The increasing load on the shaft deforms the spring even more by reducing the overall shaft length. In this case, the shaft receives less angular misalignment than in the previous initial spring tension state. Changing the resistance of the drive shaft deforms the spring, thereby securing the variator itself by changing the angular displacement of the shaft, which is firmly attached to the drive shaft, and the outer rings of the self-aligning clutch, which changes its average speed.

The influence not on the productivity of the technological machine, but only on the operating mode of the variator did not allow the use of the indicated design of the impulse variator in cotton ginning plants [17] [18] [19] [20].

Also, work was carried out to replace the IVA pulse variator with an AC electric motor reducer, which regulates the rotation speed in various ways. For this, an AC electric motor was used, which allows differently adjusting the rotation speed in a wide range.

Another area of research is improving the characteristics of the raw roll by improving the design of the feeder.

TTESI and IIHM "Research Center of the Cotton Industry" have carried out a number of significant studies in this area on the mechanisms and processes of supplying cotton ginning machines. Tyutin P.N., Lugachev A.E., Kadyrov A.A., Mansurov H.M., Yakubov B.N. Variants and schemes of control of devices for distributing fibrous material on bunkers of machines developed by the company solved the problem of uniform feeding of fibrous material and automatic operation of suppliers. The application of these schemes greatly simplifies the management of the battery operated cotton machine, but the lack of flexibility, lack of interconnection and control of machine performance, and limited operation do not provide optimal operation of the battery operated cotton machine.

R.Z. Burnashev, G. Miroshnichenko, A. Lugachev investigated the deformation of the blades of the feeding feeders in the process of feeding gin machines. In this work, the limiting deformations of the feeder blades during the supply of raw cotton, as well as the stretching of the stress, are determined.

R.V. Korabelnikov, F. Mavlyaveva, I. Khafizov studied the influence of the design of the feeder blades on one plane of the feeding process. Transmission in IVA pulse variators is carried out in the form of uneven individual pulses. As a result, the angular speed of rotation of the drive shaft (in our case, the feed roller) is periodic with respect to the angle of rotation of the drive shaft, and this is one of its main disadvantages.

R.M. Kattakhodzhaev in his theoretical and experimental studies, considered the effect of uneven transmission of cotton on the density of the raw roll, as well as the possibility of stabilizing the density of the raw roll by installing a forced rotating elastic element in the feeder.

R.M. Kattashojaev, S. Fazildinov, M. Tillaev in their work studied the effect of uneven cotton supply on the density of the raw roller.

One of the key problems in improving the gin process is maintaining a certain degree of density of the raw roll. However, it is impossible to solve this problem without knowing the nature and reasons for the change in the density of the raw roll.

The stability of the density of the raw roller in a certain range, especially when approaching the saw, leads to a decrease in the penetration of seeds into the saw teeth, which leads to damage to the seeds, and hence the mass fraction of defects and contamination...

The authors studied the process of uneven feeding of cotton into the working chamber, for which they conducted experimental studies of the influence of uneven feeding of cotton on the main parameters of the ginning process in terms of time and length of the chamber.

The density of the raw roller changes with time and the length of the working chamber, a denser layer is placed in the middle areas, fewer layers are placed at the edges, and such a pattern of change is observed with an arbitrary gin performance... The mass fraction of fiber defects and dirt also varies along the length of the machine and reaches a maximum in the center of the machine, decreasing at the edges.

R.M. Kattashojaev and S. Fazildinov showed that there is a possibility of self-leveling by the density of the raw roll by the feeder, and this feature is estimated by the self-leveling coefficient. The study proposes a certain method of theoretical calculation of the self-leveling coefficient and an analytical expression.

I.T. Maksudov and A. Azizkhodzhaev determined the degree of influence of the performance of the 3XDDM gin on the power consumed by the saw cylinder, an increase in mechanical damage to seeds, fiber and the density of the raw roll, an increase in the mass fraction of fiber defects and impurities. The authors proposed to increase the rotation speed of the raw roller, thereby increasing the productivity of the gin while maximizing the use of the natural properties of the

fiber.

B.I. Bekmirzaev to improve the quality of fibers and seeds, he developed a method for regulating the supply of cotton in accordance with the air permeability of the raw roll. The author obtained experimental results, and he came to the conclusion that the minimum fiber damage is observed at a density of 325 kg/m^3 for raw cotton grade I and 290 kg/m^3 for grade III.

A.E. Lugachev, R.Z. Burnashev, G. Miroshnichenko in their work, the plane of feeding cotton for gin machines by a feeder was studied. The main function of the feeding systems is to ensure a uniform supply of chlorine to the gin machines. However, the existing systems, consisting of a collecting hopper and a pair of six-lobe feed rollers, do not meet the technological requirements for processing raw cotton due to a certain degree of discrete feeding of cotton into the machine.

On a special stand, the authors carried out studies of the transmission plane in various feeder schemes.

A comparative analysis of the feeder designs showed that the feeder rollers are separated by a flat feed along with an oscillating pair. Therefore, it is recommended that the vibrating rollers drive the device at a higher speed, but this speed should not exceed 500 rpm, since this is due to the problem of maintaining the natural properties of cotton.

Variants of improving the systems for regulating the speed of the feeder by stabilizing the operation of the electrical system of the machine were also not used in production. The main reason for this is the relative cost and complexity of using the systems.

Recent developments have been aimed at stabilizing the speed of the motor shaft, but practice has shown that even when the speed of the drive shafts is very stable, it is difficult to obtain the expected result due to the unequal physical and mechanical properties of the material, the effect of stability at high speeds is eliminated. An independent AC drive motor driven by a hig speed rectifier was also used as a drive. A thyristor, a four-layer semiconductor device, was also used as a regulating element.

In the process of ginning raw cotton, there is a relationship between productivity, density of the raw roll and the quality of the produced fiber and seeds.

As shown by most of the studies on this topic, carried out at "cotton industry science center" JSC and TITLP, the main reason for the occurrence of ginning defects in the fiber is the high and unstable density of the raw fiber. With an increase in the density of the raw roll, flagella, combined flagella, nodules are formed, which negatively affect the spinning process [4] [5] [6].

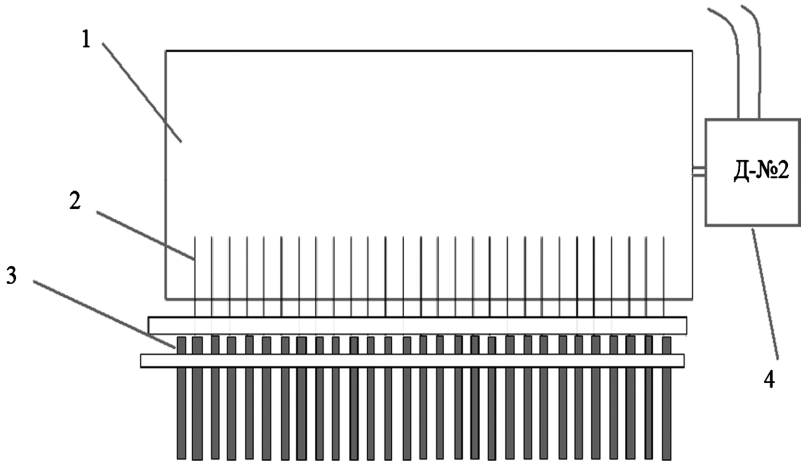
The density of the raw roll is determined by the state of dynamic equilibrium of several factors—nutrition, as well as fiber and separated seeds from the working chamber.

The authors recommend the control of the power supply system by the sensor 8 installed on the front apron of the working chamber of the saw gin, where the feeder signal falls, as a result of a change in the rotation of the feed roller.

The improved working chamber (Figure 2) of the saw gin works as follows.

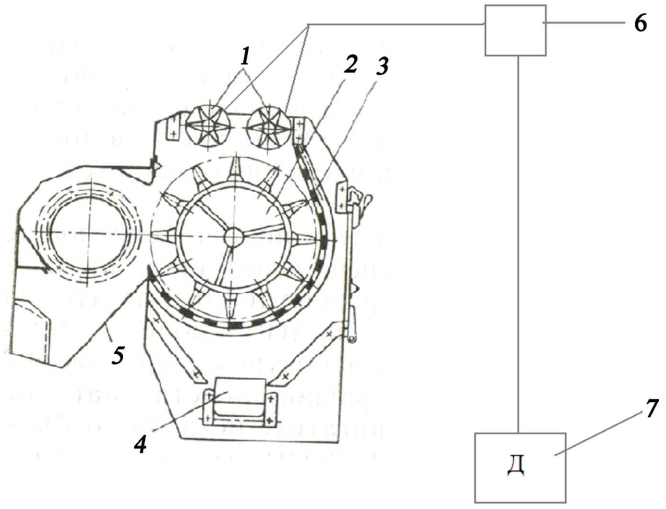
The incoming raw cotton into the working chamber of the saw gin contacts the saw cylinder 4, where the raw roller 7 is formed. From the raw roller 7, through the grate 3, using the saw cylinder 4, the fiber is removed from the working chamber. Here, the seed output is regulated by the position of the seed comb 5. When the density of the raw roller 7 changes, the sensor 8 installed on the front apron transmits a signal to the sensor installed in the feeder, respectively, the feeder load changes, and enables stable operation of the working chamber of the saw gin. As a result, the speed of the feeder and the amount of cotton, the raw gin falling into the working chamber, change.

They use of a feeder control system (Figure 3) and uniform loading of the



1—raw roller; 2—saw cylinder; 3—grate; 4—a sensor measuring the load of the action of the raw roller on the front apron of the working chamber.

Figure 2. Scheme of the working chamber of the saw gin.



1—feed rollers, 2—pegs drum, 3—mesh grate, 4—belt conveyor for garbage removal, 5—tray for feeding raw cotton into the gin working chamber, 6—electric motor of the feed rollers, 7—load sensor of the raw roller on the front apron of the working saw gin chambers.

Figure 3. The established scheme of operation of the saw gin feeder.

working chamber with cotton allows: to maintain the density of the raw roll, to drastically reduce the space of the gins due to the prevention of their bottoming, which leads to stable operation of the gins and an increase in their productivity. As a result of the uniform work of the gin, the quality indicators of the fiber, as the mass fraction of defects and trash impurities, are improved.

The quality indicators for I- and III-varieties of raw cotton, obtained as a result of tests on the existing gin 4DP-130 and on gin 4DP-130 with a nutrition control device are shown in Table 2. As can be seen from the table, as a result of uniform operation of the gin, such fiber indicators, such as the mass fraction of flaws and trash impurities and the staple mass of length. Also, the quality indicators of seeds improved, in particular, their mechanical damage and drooping decreased (Table 2).

3. Results

The test results showed that the introduction of a 4DP-130 saw gin feed control device, ensuring a uniform loading of the working chamber, allows to obtain higher quality fiber and seeds when processing raw cotton on gins with an adjustable raw roller density. During production tests, the following results were obtained on the quality indicators of the fiber, in particular, when processing raw cotton of I- and III-grades, the mass fraction of defects and trash impurities decreased by 0.5% and 0.2%, respectively, the staple specific length increased by 0.1 mm and 0.2 mm.

4. Conclusions

As most of the studies on this topic show, the main cause of ginning defects in fiber is the high and inconsistent density of raw fiber. With an increase in the density of the raw roll, flagella, combined flagella and nodules are formed, which negatively affect the spinning process.

Improving the process of feeding the saw gin makes it possible to regulate the

Table 2. Comparative results of experiments carried out on saw gins with different food systems on cotton C65-24 I- and III-grades.

№	Qualitative indicators	4DP-130		4DP-130 with a new power system	
		I-grade	II-grade	I-grade	II-grade
1	Productivity, kg/saw-hour	8.0	7.0	8.0	7.0
2	Moisture content of raw cotton, %	8.0	9.0	8.0	9.0
3	Content of impurities raw cotton, %	1.4	2.6	1.4	2.6
4	Mass fraction of vices and weeds, %	2.6	3.8	2.0	3.4
5	Staple weight, length, mm	33.4	29.4	33.6	29.8
6	Mechanical damage to seeds after gin, %	3.2	6.8	1.4	3.6
7	Seed downiness%	12.6	12.6	11.2	11.6

supply of raw cotton to the working chamber.

A sensor installed on the front apron of the sawing chamber working chamber drops a signal into the feeder, as a result of which the rotation of the feed roller changes.

As a result, the density of the raw roller is regulated, which ensures the stable operation of the saw gin.

The introduction of a device for regulating the power supply of the saw gin provides a uniform loading of the working chamber and allows to obtain a higher quality fiber when processing raw cotton and gins with an adjustable density of the raw roller.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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